

# Summary of the BNL Associate Laboratory Director's Status Review of the U.S. ATLAS Phase II Upgrade Project

The review was held at Brookhaven National Laboratory on 20-22 January 2016. The closeout slides, which also include the Charge and the names of the committee members, are attached to this summary. The Charge states, "The purpose of this review is to assess the maturity and status of the U.S. ATLAS Phase II project plan, with the goal of evaluating its state of readiness for meeting agency expectations for a project at the conceptual stage." In the Charge, there are seven groups of questions about the Design, R&D plan, Scope, Cost & Schedule, Risk, Management & ES&H, and Documentation. A particular focus was on the clarity and definition of the respective NSF and DOE roles, in the context of the broader international ATLAS effort. This review considered one component of a larger worldwide ATLAS upgrade activity, which itself is one component of the LHC program.

For efficiency, the committee was divided into four subcommittees: Silicon Trackers (SC-1); Calorimeters (SC-2); Muon, Trigger, Data Handling/DAQ (SC-3); and Management, Cost, and Schedule (SC-4). The results of the parallel work by the subcommittees were discussed and considered by the full committee, and the report is a product of the full committee. Detailed Findings, Comments, and Recommendations, along with the answers to the seven groups of questions in the Charge, are included in the attached slides.

The committee had the following overall remarks about what it reviewed:

- The proposed U.S. contributions to the ATLAS upgrade are based on the specific expertise, experience, and track record of the team, which is excellent. U.S. personnel have intellectual leadership of all the major aspects of these contributions. The proposed contributions were defined as part of a global ATLAS optimization of the scope and scientific capabilities of the proposed design. U.S. participation is essential to the success of the global ATLAS program.
- The proposed respective roles of the agencies are well defined, thoughtfully optimized, and clearly described.
- As the ATLAS and CMS upgrade programs will be reviewed concurrently in a combined MREFC process, coherence and uniformity of the documentation and review preparation will be beneficial.

Feedback by the committee on the NSF Project Execution Plan (PEP) and on the presentations can also be found in the slides. A recurring theme is the importance of considering the audience carefully when choosing how best to present the information about this exciting, multifaceted project. In particular,

- The process that was followed (and how it was documented) to optimize the ATLAS design and to flow down the requirements should be described more fully. Similarly, the technical management processes that will be used throughout the rest of the project cycle (design maturation, construction, testing and verification) should be described more clearly, with attention to terminology. For example, the Technical Coordination Team plays many of the roles that might be called System Engineering (SE) in other projects. The description of SE roles should be written clearly to reflect the actual plan. Specific heritage and lessons from prior ATLAS construction should be cited when appropriate. The Committee commends the ATLAS team for understanding the importance of system integration engineering.
- Showing the fraction of global core scope (and how “core” is defined) provided by the U.S. down to the level of detail corresponding to 100% (or as close to that as possible, generally), and highlighting U.S. intellectual leadership in those areas, helped this committee to assess what is being proposed. The consequences of exercising scope reduction options in ATLAS are somewhat different from those of more self-contained MREFC projects. How budget contingency and scope contingency are managed in the context of international ATLAS should be explained clearly and concisely.

These steps would help avoid potentially damaging misunderstandings. The committee also suggests soliciting feedback on the next draft version of the PEP from project managers of recent MREFC projects (*e.g.*, LSST, IceCube, aLIGO) and other physical sciences projects. More detailed suggestions and observations about the draft PEP and the presentations can be found in the attached slides.

## Recommendations

- 1) **Complete the process of identifying the main schedule drivers for both the pixel detector and strip tracker projects by DOE CD-1. (Project scope is entirely DOE.)**
- 2) **Rewrite the PEP sections to give enough detail on the P5 science drivers and on the specific examples of the physics considered for scoping, so that a non-expert has a sense of their nature and importance. Explain the main scientific examples so as to provide a non-expert with a general sense of the important issues. Enunciate the accelerator facts and the way that they dictate project scope. For an example, use a relatively high level deliverable (*e.g.*, L1 CALO Trigger) to show how the ATLAS Scope document formulates the nature of the deliverable based on the scientific goals.**
- 3) **Regarding Risk Management and the Risk Register:**
  - **Prior to CDR:**
    - **Add mitigation actions into the Risk Register for all identified risks.**
    - **Modify the PEP description of the risk management process to make it clear that the full integration team is engaged in concurrent evaluations of both registries.**

- Add description to the PEP (Section 6.3 – Contingency) on how contingency will be tied into risk management.
- After CDR:
  - Fully develop the risk register with impact assessment. Consider schedule risks as well as cost risks to justify schedule float.
  - Include the possible instances of failures of deliveries by non-US collaborators in the risk register.

**4) Proceed to NSF CDR.**

**Acknowledgements**

The committee thanks the U.S. ATLAS team for the thoughtful, effective presentations and open, frank discussions; BNL staff, especially Winnie Yu, for all the logistical support, which enabled a smooth review; and the agencies, for their engagement in this remarkable project that is of critical importance to particle physics.

# Closeout Report for the BNL Associate Laboratory Director's Status Review of the U.S. ATLAS Phase II Upgrade Project

Brookhaven National Laboratory  
January 20-22, 2016

# Thanks!

- Thanks to
  - the whole US ATLAS team for the thoughtful, effective presentations and open, frank discussions.
  - BNL staff, especially Winnie Yu, for all the logistical support, which enabled a smooth review.
  - the agencies, for their engagement in this remarkable project that is of critical importance to particle physics.

**BNL Associate Laboratory Director's Review of the  
U.S. ATLAS Phase II Upgrade Project  
January 20-22, 2016**

**Steven, Ritz, UC Santa Cruz, Chairperson**

<b>SC-1 Silicon (Pixels, Strips and Global Mechanics)</b>	<b>SC-2 Calorimeter (Liquid Argon, TileCal)</b>	<b>SC-3 Muon, Trigger and Data Handling/DAQ</b>
* Ronald Lipton, FNAL Anadi Canepa, FNAL Hassan Jawahery, U. of Maryland	* Daniel Marlow, Princeton U. Regina Rameika, FNAL Monica Tecchio, U. of Michigan	* Darien Wood, Northeastern U. Karsten Heeger, Yale U. Stephen Wolbers, Oregon State U.
<b>SC-4 Management, Cost and Schedule</b>		
* Paul Grannis, Stony Brook U. Dmitri Denisov, FNAL Ritchie Patterson, Cornell U. Mark Reichanadter, SLAC		

# Overall Remarks

- This was a review of an excellent team. Note that the review considered one component of a larger worldwide ATLAS activity, which is one component of the LHC program.
- The proposed U.S. contributions to the ATLAS upgrade are based on the specific expertise, experience, and track record of the team. U.S. personnel have intellectual leadership of all the major aspects of these contributions. The proposed contributions were defined as part of a global ATLAS optimization of the scope and scientific capabilities of the proposed design. U.S. participation is essential to the success of the global ATLAS program.
- The proposed respective roles of the agencies are well defined, thoughtfully optimized, and clearly described.
- As the ATLAS and CMS upgrade programs will be reviewed concurrently in a combined MREFC process, coherence and uniformity of the documentation and review preparation will be beneficial.

# Overall Remarks (2)

- The draft PEP is a fine start, but it should be improved (specific suggestions on separate slides) to convey the plans more effectively.
- The consequences of exercising scope reduction options in ATLAS are somewhat different from those of more self-contained MREFC projects. This should be explained at the CDR in the discussion of scope and cost management.
- The team is commended for understanding the importance of system integration engineering.
- Presentations:
  - Presentations and documentation (including the PEP) should consider the audience carefully, avoiding jargon whenever possible and ensuring acronyms are defined. Also, explain clearly the relationship between US ATLAS and Global ATLAS.
  - Consider adding the biggest challenges for each subsystem in the plenary talks and how these are being addressed. These should also be consistent with the Risks.
  - Define terms for the ATLAS detector in all its phases (*e.g.*, “current” is unclear).
  - Show the fraction of global core scope provided by the U.S. down to the level of detail corresponding to 100% (or as close to that as possible, generally), and highlight U.S. intellectual leadership. Also show illustrations indicating (shading, *e.g.*) the U.S. contributions.
  - For each subsystem provide a summary of milestones and decision points that show the path from the conceptual design to the TDR.
  - Whenever possible, emphasize the long-term experience of the collaboration and subsystems in the development of the proposed technical upgrades. Describe what systems are an evolution of an existing system vs those requiring R&D.
  - List the names of the technical integrators/coordinators if known.
  - See SC reports for additional suggestions.

# Overall Recommendation

- Proceed to CDR.

# Comments on the PEP

- Especially given the first bullet in the NSF CDR charge, it is necessary to describe more fully the process that was followed (and how it was documented) to optimize the ATLAS design and to flow down the requirements. For example:
  - Start with the high-luminosity physics motivation,
  - which implies specific fundamental changes in the experimental environment,
  - which result directly in changes to the measurement, radiation tolerance, and trigger requirements,
  - which lead to specific electronics and sensor upgrades, over a plausible range of scopes,
  - and the science performance over this range was evaluated in full-ATLAS trade studies using detailed simulations. The trade study results were reviewed by an independent panel. Show examples with plots, and point to the scope document and any available relevant review outcome documents.
- Similarly, the technical management processes that will be used throughout the rest of the project cycle (design maturation, construction, testing and verification) should be described more clearly, with attention to terminology. For example, the Technical Coordination Team plays many of the roles that might be called System Engineering (SE) in other projects. The description of SE roles should be rewritten to reflect the actual plan. Specific heritage and lessons from prior ATLAS construction should be cited when appropriate.

# Comments on the PEP

- “Mail-in review” feedback on the updated draft PEP should be solicited from project managers of recent MREFC projects (e.g., LSST, IceCube, aLIGO) and other physical sciences projects.
- The text should be carefully edited to fix errors (grammar, usage, style, ...) and remove unnecessary jargon.
- Many headline points are buried in the middle of paragraphs in the middle of many pages of text. Some are missing. For example,
  - The operations cost change implications of this proposal are likely different (and smaller) than those of most MREFC projects.
  - The LHC program, including the upgrades, is strongly supported as a top priority in the community (Snowmass, P5, MPS Panel report,...). The scientific motivations for the luminosity increase should be described in a few exciting paragraphs (beyond quoting P5 Drivers). The discovery potential is great and will be sustained over many years.
  - Without hype, some of the astounding properties of ATLAS and the LHC should be stated for the non-expert to help give a perspective.
  - *“The NSF scope has been defined in such a way as to minimize dependencies on any other partners in order to minimize external risks to the project.”* (p30, middle of a paragraph about DOE)
  - *“The total project cost is \$75M including a total contingency of \$22.5M in AY\$. We note that the DOE scope which is not addressed in this document totals \$150M (TPC in AY \$)”.* (p45)
  - Show a table of main outcomes needed from the R&D program.

# Comments on the PEP

- Scope contingency management and technical management sections should be revised (per earlier comment).
- If possible, the Operations Plan section should explain more quantitatively the heritage as a basis of estimate and how the HL era may be different, and why the operations cost increments are expected to be relatively small.
- Note that individual committee members may also be sending additional comments and suggestions about the PEP.

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Findings (1)
  - The upgrade of the tracking system in the ATLAS detector is absolutely critical to achieving ATLAS physics goals at the high luminosity LHC with average inelastic interactions per bunch crossing of up to 200.
  - The upgrade tracking system (ITk) is an all-silicon tracker designed to provide tracking up to  $|\eta|=4$ . In the baseline layout, the central (barrel) region is instrumented with five layers of hybrid pixel sensors at the inner radii and 4 layers of silicon strip detectors at the larger radii. The end-cap region is instrumented with pixel disks (the number of pixel disks is yet to be defined) and 6 silicon strip disks at each end.
  - The ATLAS Collaboration developed a comprehensive set of simulation studies to assess the science requirements corresponding to the science goals of the HL-LHC. The conceptual design derived from the science requirements is sound.
  - The LOI and the scoping document provide a clear description of the expected performance of the tracker and its impact on physics goals of the ATLAS experiment at HL-LHC are well described.
  - The technical approaches are the result of many years of R&D focused on tracking needs for ATLAS in the HL-LHC environment.

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Findings (2)
  - The US ATLAS collaboration has made major intellectual contributions to the design and development of the system and has key responsibilities in the R&D and construction of both the pixel and silicon strip systems. These include:
    - In the pixel system: production of detector modules, electrical and optical data transmission, integration, mechanics, and local support, including design and production of I-beams, twisted pairs, stave flex, end-of-stave cards, and stave loading at a total budget of \$28.3 M.
    - In the silicon strip system: design and production of stave cores, readout and control electronics, assembly, testing and integration of the detector modules at a total budget of \$37.9M.
    - The Global Mechanics effort has responsibility for design and fabrication of the pixel support tube, ITK outer cylinder and bulkhead, and thermal barrier.
      - An overall goal is to enable rapid installation of both the pixel and strip systems by allowing assembly and substantial interconnection on the surface.
      - The thermal barrier may not be necessary

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Findings (3)
  - The strip detector and module layouts are finalized. Extensive R&D has been developed for several years. Prototype modules have been mounted on staves.
  - In the US, three centers (LBNL, BNL, UCSC) will produce the required modules over the course of four years starting in FY19
  - A two-phase pre-production is planned (FY17: 1% of the full production; FY18: 5% of the full production)
    - If funding is limited in FY17 and FY18, only one of the three sites will enter the pre-production phase. This may cause a delay of the production phase and the need for increased person-power during the production phase.
    - The final chip ABC\* is being designed primarily by international collaborators. If the ABC\* chip is not available for the pre-production phase, the US sites will use the available ABC130 chip for the prototype modules (the ABC\* utilizes the front end and much of the digital logic of the tested ABC130).
  - The production of the pixel detector will commence in FY19
    - The detector and module layouts are not finalized yet. International-ATLAS will finalize the detector layout by Fall 2016.
  - The schedule of the pixel detector is built on the assumption that the submission of the RD53A chip is successful. This relies on the reliability of the 65nm CAD tools.

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Findings (4)
  - Most of the US institutions involved in the ITk project participated in the construction of the current inner detector (namely: IBL, Pixel, SCT). Institutions that were not directly involved in the construction of the current inner detector have successfully led other detector construction projects

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Comments (1)

- Strip Tracker Project:

- the anomalous current consumption for the 130 nm chips at the 5MRad radiation level is an established feature of the process. The increase in current can affect the design of the power supplies and DC-DC converters. The strip tracker project is encouraged to develop a plan to address this issue.

- Pixel Detector Project

- The module layout, stave support structure and the overall geometry (barrels vs “tilted barrels”) are not yet defined. If the tilted design is selected, the mechanical design will be revisited. This may cause a delay of the production phase with respect to the default schedule.
    - The forward pixel extension is also under discussion. Although this is not a US deliverable, different detector layouts may require different supports. These are US-deliverables.
    - The start of production may be delayed if a repeated submission of the RD53 chip is necessary. . The pixel detector project is encouraged to develop a plan to address this risk.

- Global Mechanics Project

- Much of this work is similar to recent work on ATLAS pixel, and HFT and Phenix structures for RHIC and should have low to moderate technical risk
    - An overall ATLAS schedule for delivery of the mechanics and installation at CERN is needed

- The R&D request in FY17 is 5.8M\$. The budget allocation is 2.6M\$. The R&D activities will have to be carefully prioritized to provide support for critical path items, and pre-production startup may be delayed.

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Comments (2)
  - Additional CD-1 preparation steps could include:
    - Define the schedule drivers as milestones in the schedule
    - Describe in details the R&D goals (including assessment of SEU and TID for RD53) and specification for the ASIC and read-out system.
    - Consolidate the schedules presented in the plenary/parallel talks and those linked from DocDB and fix the typos in the schedule charts.
    - Define the float for each sub-project.

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

- Recommendations
  - Complete the process of identifying the main schedule drivers for both the pixel detector and strip tracker projects by DOE CD-1. (Project scope is entirely DOE.)

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

## Design:

Are the project's performance goals well motivated and understood? **Yes.** *The LOI and Scoping document provide a comprehensive review of the physics goals, the physics requirements and the technical requirements for the upgrade of the inner detector.*

Is the conceptual design sound and likely to meet the project's performance goals effectively and efficiently? Are the technical approaches adequately justified in the conceptual design, Letter of Intent and related supporting documentation? **Yes.** *There has been careful study of technical and design issues including pixel and strip layout, powering strategy, pixel chip design requirements, and data flow. These approaches are described in the scoping document, RD53 specifications, and other documentation*

R&D: Is there an appropriate R&D plan in place that adequately supports ongoing design development and the down select of alternatives on the currently anticipated time scales? **Yes, but see Comment on slide 13.**

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

## Scope:

Are the project's scope and specifications sufficiently defined to support the cost and schedule estimates?

*Yes, the baseline scope is well defined for both projects as documented in the Scoping Document (and in the plenary/parallel presentations.) In cases where the deliverables are shared among international institutions, the division is well defined.*

Have the scope and physics performance priorities been clearly identified? **Yes.** *The prioritization process needed in case of reduced funding was described in the plenary and parallel presentations: deliverables where the US has leadership and that may cause a significant delay to the entire ITk projects are considered high priority. Major de-scoping in case of severe funding limitation will be discussed with the ATLAS management as expected in large collaborative efforts.*

Are the scope designations and responsibilities for the NSF and DOE well defined? **N/A** *in this case. The project is fully funded through the DOE.*

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

## Cost and Schedule:

Are the cost and schedule estimates credible and realistic for this stage of the project? **Yes.** *The cost and schedule are realistic and well advanced for this stage of the project, although the schedule for the pixel detector production does not account yet for an already known delay in the chip submission (~6 months). Furthermore the schedule assumes completion of the R&D work for the strip tracker in FY17 and FY18. Any delay of this R&D could impact production planning. The schedule for global mechanics will be refined in collaboration with international ATLAS.*

Has scope contingency been identified and integrated into the project plan? **Yes.** *The scope contingency (and scope opportunity) has been identified. The contingency is categorized depending on the impact on the US scope.*

Do the estimates include adequate scope, cost and schedule contingency? **Yes.** *At this point in the project all contingency estimates are top down. The BOE and risk register provide the information for a more bottom-up estimate.*

Does the cost estimate include realistic assumptions of labor costs, M&S and anticipated support from the core research program? **Yes.** *Two of the largest BOEs (Modules for the Strip Tracker and Module & Integration for the Pixel detector) were examined in detail. Many of the estimates are based on experience with the Phase 1 project and initial detector construction. Global mechanics bases its estimate on database extraction of costs of similar projects.*

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

## Risk:

Have risks been adequately identified for this stage in the project? **Yes.** *An appropriate risk analysis is reported in the BOEs. Identified major schedule risks include potential delays in the pixel chip procurement process and delay of the stave pre-production due to lack of R&D funding. Global risks are identified by PM.*

Have they been appropriately taken into consideration in the determination of the cost, schedule and scope contingency estimates? *Yes for cost and scope. The above-mentioned risks have not been yet incorporated into a detailed project schedule. This is not unexpected at this stage of the project.*

Has the risk of possible funding and/or approval delays early in the project life cycle been properly taken into account? **Yes,** *a mitigation plan has been developed by increasing the module and stave production rate for the strip tracker*

Does the R&D plan include mitigation of these risks where possible? **Yes.**

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

## Management and ES&H:

Is the project being effectively managed at this stage? **Yes.** *The administrative, technical and management teams are formed and the roles assigned in most of the cases. The L2 managers are identified and acting.*

Are the roles and responsibilities of the managers at all levels well understood by the principals? **Yes.** *Roles and responsibility (including system integration engineers) will continue to evolve as the project matures.*

Do the management structure and processes effectively support the design effort? **Yes,** *consistent with the stage of the project.*

Are the criteria, processes, and timeframes for the major decisions concerning down selects, scope optimization, and assignment of activities well understood? **Yes.** *The US project is integrated in the International-ATLAS ITK project at management and project levels. The scope optimization and down-selection (“tilted modules”) are coordinated within International-ATLAS. The process and the criteria are therefore well established.*

Is the integration with International ATLAS well defined and understood? **Yes** *(see above).*

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

Has the rationale for the NSF and DOE roles been clearly articulated, and are they well motivated and optimized? **N/A** *in this case. The project is fully funded through the DOE.*

Are ES&H aspects being properly addressed, and are the plans sufficient given the project's current stage of development? **N/A** *The committee did not address ES&H aspects of the project due to lack of time.*

# SC-1 Tracker

R. Lipton\*, FNAL; A. Canepa, FNAL; H. Jawahery, Maryland

Documentation: Is the documentation currently in place adequate to support the project plan, scope, and cost and schedule estimates being presented? **Yes**, *based on the reviewed documents (LOI, Scoping Document, selected BOEs, Summary Schedule, Global and Deliverable Risk Registry).*

Do the NSF CDR and NSF Project Execution Plan fulfill the NSF's expectations for conceptual design? **N/A** *in this case. The project is fully funded through the DOE.*

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

- Findings (LAr)
  - The HL-LHC upgrade for the LAr calorimeter will provide new front-end (FE) electronics including pre-amp/shaper and digitization for ~180K channels, optical transmitters and new back-end (BE) electronics to process the data, providing inputs to the TDAQ system.
  - Two scope “opportunities” were also presented within this sub-system, namely an FCAL replacement (sFCAL) and a high-granularity timing detector (HGTD)
  - The front ends, optical transmitters and back ends are within the NSF scope (\$19.1M) while the pre-amp/shaper and the system integration (\$6.1M) are the DOE scope.
  - The LAr calorimeter electronics upgrades are being carried out by groups that have experience with the LAr calorimeter system from both the original ATLAS and the Phase-I upgrades, currently underway.
  - Requirements on the front-end system are low noise, rad-hardness and, high rate capability. The required beam tests for rad-hardness are built into the on-going R&D program.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

- Comments (LAr)
  - The LAr calorimeter electronics teams are well coordinated and have a good handle on the time scales and funding issues.
  - Pre-MREFC funding for the time period FY17-19 is important to insure that once MREFC funding is in place final prototyping followed by production can commence.
  - The BOEs that we reviewed (FEB2 ADC ASIC and LPPR board) were complete and well developed.
  - The requirements for the ADCs in the FEB2 board are challenging.
  - The design effort is leveraging the use of EE expertise at collaborating universities and availability of EE students at the Ph.D. level.
  - The issue of interface and integration with general infrastructure elements (i.e., heating, cooling, power distribution) were not addressed in great detail.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

- Findings (Tile Cal)
  - The Tile Calorimeter Upgrade will preserve the energy resolution on jets and missing energy trigger objects in the face of increased rates at the HL-LHC.
  - The detector is not changed. The electronic readout is changed to make data from all cells available to the trigger at the full 40 MHz rate.
  - The upgrade will also address observed early board mortality, and will simplify the mechanical and interconnect design.
  - The Tile Cal is funded solely by the NSF and is estimated to cost \$1.85M between FY16-19 and \$3.7M between FY20-24.
  - The cost, schedule and management are based on the design of the original detector and the full wedge prototype.
  - Two alternate ASICs are under consideration. They will be used only if tests demonstrate advantages in physics performance over the existing 3-in-1 board design.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

- Comments (Tile Cal)
  - Well advanced R&D has culminated in a full wedge prototype of all new readout electronics, which was tested at CERN last year.
  - The project is already very mature, due to previous expertise and extended work on the full wedge prototype.
  - The scope is well defined, the division of responsibilities among different universities is clear, and the risk of failure is low.
  - Test beam is planned for 2018 to establish the jet energy scale, after the choice of electronics has been finalized.
  - The new LV and detector control board (ELMB++) needs specifications from global ATLAS.
  - There is a clear path toward project completion over the FY20-24 period.
  - Reviews of the BOE for two subprojects (Main Board and Pre-Processor TDAQ) found solid bases for cost estimate, risk assessment and risk mitigation.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

- Comments (Other)
  - The High Granularity Timing Detector is a US scope opportunity requiring further R&D. The physics benefits have not yet been fully quantified and a proof-of-principle demonstration remains to be made.
  - The FCAL replacement and the HGDT are listed as requirements in the introductory section of the PEP, whereas they are not included in the US base scope of the calorimeter subproject.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

- Recommendations: None

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

## 1. Design:

1. Are the project's performance goals well motivated and understood? **Answer:** Yes in broad measure, although detailed studies are ongoing.
2. Is the conceptual design sound and likely to meet the project's performance goals effectively and efficiently? **Answer:** Yes, although work remains to determine the extent of possible radiation degradation (if any).
3. Are the technical approaches adequately justified in the conceptual design, Letter of Intent and related supporting documentation? **Answer:** For the most part, yes, although the FCAL and the HGDT remain under study by ATLAS. (Neither item is in the base US scope. A review of FCAL options is planned for June 2016 and a decision on HGDT is expected in May of 2017.)

2. R&D: Is there an appropriate R&D plan in place that adequately supports ongoing design development and the down select of alternatives on the currently anticipated time scales? **Answer:** Yes. There is a down select involved in the Shaper/Preamplifier. For the Tile Cal, R&D is largely complete. There is concern over timely availability of funds for LAr electronics.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

## 3. Scope:

1. Are the project's scope and specifications sufficiently defined to support the cost and schedule estimates? **Answer:** In most cases, yes. Items not in that state (FCAL and HGDT) are not in the base US scope.
2. Have the scope and physics performance priorities been clearly identified? **Answer:** Yes.
3. Are the scope designations and responsibilities for the NSF and DOE well defined? **Answer:** Yes

## 4. Cost and Schedule:

1. Are the cost and schedule estimates credible and realistic for this stage of the project? **Answer:** Yes. Indeed, they surpass expectations.
2. Has scope contingency been identified and integrated into the project plan? **Answer:** Yes, this has been at an appropriate level of detail.
3. Do the estimates include adequate scope, cost and schedule contingency? **Answer:** Yes, they are adequate for this stage.
4. Does the cost estimate include realistic assumptions of labor costs, M&S and anticipated support from the core research program? **Answer:** Yes.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

## 5. Risk:

1. Have risks been adequately identified for this stage in the project? **Answer: Yes.**
2. Have they been appropriately taken into consideration in the determination of the cost, schedule and scope contingency estimates? **Answer: Yes.** The consideration is appropriate for this stage.
3. Has the risk of possible funding and/or approval delays early in the project life cycle been properly taken into account? **Answer: Yes, but see Comment on slide 24.**
4. Does the R&D plan include mitigation of these risks where possible? **Answer: Yes.** Risks have been considered and mitigation strategies have been developed.

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

## 6. Management and ES&H:

1. Is the project being effectively managed at this stage? **Yes.**
2. Are the roles and responsibilities of the managers at all levels well understood by the principals? **Yes.**
3. Do the management structure and processes effectively support the design effort? **Yes.**
4. Are the criteria, processes, and timeframes for the major decisions concerning down selects, scope optimization, and assignment of activities well understood? **Answer: For items in the base US scope, yes.**
5. Is the integration with International ATLAS well defined and understood? **Yes.**
6. Has the rationale for the NSF and DOE roles been clearly articulated, and are they well motivated and optimized? **Yes.**
7. Are ES&H aspects being properly addressed, and are the plans sufficient given the project's current stage of development? **Answer: the SC-2 subcommittee did not have an opportunity to consider these.**

# SC-2 Calorimetry

D. Marlow\*, Princeton; R. Rameika, FNAL; M. Tecchio, Michigan

## 7. Documentation:

1. Is the documentation currently in place adequate to support the project plan, scope, and cost and schedule estimates being presented? If not, where are the deficiencies? **Answer: Yes.**
2. Do the NSF CDR and NSF Project Execution Plan fulfill the NSF's expectations for conceptual design? **Answer: The cost and schedule information is adequately documented. The PEP would benefit from a clearer statement of how the requirements were derived. Use the ATLAS heritage to clarify the motivation for the components of the upgrade.**

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

- Findings

- The DAQ, trigger, and muons system presented a comprehensive package of the scientific motivation and project structure of these WBS elements.
- A two-level hardware trigger system for detector readout and data preparation is proposed to accommodate the high trigger rates and large event sizes expected during HL-LHC running
- The proposed muon upgrade involves the construction of monitored small drift tubes as well as boards for data taking and readout in the high-rate environment of the HL-LHC
- In both muon and trigger/DAQ, the HL-LHC tasks are typically carried out by groups with extensive experience on the same subsystems in the original ATLAS detector and/or the Phase 1 upgrades
- Muon (5 deliverables) and Trigger (4 deliverables) are all in the NSF scope, while DAQ/Data handling (4 deliverables) are all in the DOE scope.
- Some critical hardware choices are scheduled to be resolved at an Initial Design Review (IDR) in Summer 2016, leading to TDRs in mid-2017.
- The subcommittee examined in detail the BOEs for 6.6.y.3 (sMDT chambers), 6.6.y.4 (Hit Extractor Board), 6.7.y.2 (L1Trk/FTK++) and 6.8.x.3 (L1Global) and found detailed cost estimates including risk analyses and mitigation plans.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

- **Comments**

- The muon upgrade is well motivated by the need for increased efficiency and sharper  $p_T$  thresholds for the trigger.
- The trigger upgrade is well motivated by the requirements of the physics program and the improved capabilities of the detectors at the higher HL-LHC luminosities.
- The information provided to the committee, particularly the BOE documents, was found to contain a greater level of detail than expected for the conceptual design at this stage of the project.
- The subsystems and overall management team work well together and reflect years of experience working on ATLAS.
- In review presentations and documentation, it would be useful to highlight the correlations between what groups did for the original ATLAS detector and Phase 1 and what they are committing to do on Phase 2.
- The Phase 1 trigger upgrade is an important component of the evolution of the trigger system and provides important input to inform decisions on the Phase 2 trigger upgrade.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

- Recommendations: None.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

## 1. Design:

Are the project's performance goals well motivated and understood?

Yes. It was clear, for example, that the trigger rate control of muons cannot be achieved in HL-LHC by raising  $p_T$  thresholds, which would strongly compromise physics capability.

Is the conceptual design sound and likely to meet the project's performance goals effectively and efficiently?

Yes. By including the MDTs in the trigger and increasing the trigger rate, ATLAS will be able to trigger efficiently on muons from W and Z decays.

Are the technical approaches adequately justified in the conceptual design, Letter of Intent and related supporting documentation?

Yes, although the logical flow from physics requirements to technical approaches could be made more evident in the PEP.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

2. R&D: Is there an appropriate R&D plan in place that adequately supports ongoing design development and the down select of alternatives on the currently anticipated time scales?

Yes. The R&D plan looks sufficient to make the decisions required. The presentations during the breakouts helped clarify many of the issues. It would help to identify the critical design decisions, when they will take place, and what R&D is needed for these decisions in both the overview talks, and the subsystem presentations.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

## 3. Scope:

Are the project's scope and specifications sufficiently defined to support the cost and schedule estimates?

Yes, the scope and specifications are well defined in subsystem documentation and BOE.

Have the scope and physics performance priorities been clearly identified?

Yes.

Are the scope designations and responsibilities for the NSF and DOE well defined?

Yes. Muon and Trigger are all in the NSF scope, while DAQ/Data handling are all in the DOE scope.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

## 4. Cost and Schedule:

Are the cost and schedule estimates credible and realistic for this stage of the project?

Yes, we examined the BOEs for 6.6.y.3 (sMDT chambers), 6.6.y.4 (Hit Extractor Board), 6.7.y.2 (L1Trk/FTK++) and 6.8.x.3 (L1Global). They were thoughtful and sufficiently detailed for this stage of the project.

Has scope contingency been identified and integrated into the project plan?

Yes.

Do the estimates include adequate scope, cost and schedule contingency?

Yes, the estimated contingencies seemed appropriate given the planning stage of the project.

Does the cost estimate include realistic assumptions of labor costs, M&S and anticipated support from the core research program?

Yes. The assumptions were made clear in the BOEs and consistent with overall project planning and institutional responsibilities for the proposed upgrade.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

## 5. Risk:

Have risks been adequately identified for this stage in the project?

Yes, we examined the BOEs for 6.6.y.3 (sMDT chambers), 6.6.y.4 (Hit Extractor Board), 6.7.y.2 (L1Trk/FTK++) and 6.8.x.3 (L1Global). In all cases the technical, cost, and schedule risks were well-identified.

Have they been appropriately taken into consideration in the determination of the cost, schedule and scope contingency estimates?

Yes.

Has the risk of possible funding and/or approval delays early in the project life cycle been properly taken into account?

Yes, it is addressed with schedule float.

Does the R&D plan include mitigation of these risks where possible?

Yes, where possible, but some risks are external and cannot be mitigated with R&D.

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# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

## 6. Management and ES&H:

Is the project being effectively managed at this stage?

Yes.

Are the roles and responsibilities of the managers at all levels well understood by the principals?

Yes.

Do the management structure and processes effectively support the design effort?

Yes.

Are the criteria, processes, and timeframes for the major decisions concerning down selects, scope optimization, and assignment of activities well understood?

Yes, this was described at a high level. A summary at the subsystem level would be helpful.

Is the integration with International ATLAS well defined and understood?

Yes.

Has the rationale for the NSF and DOE roles been clearly articulated, and are they well motivated and optimized?

Yes, Muons and Trigger are clearly defined as NSF. DAQ/Data handling (DOE) is closely connected to Trigger (NSF).

Are ES&H aspects being properly addressed, and are the plans sufficient given the project's current stage of development?

Yes.

# SC-3 TDAQ/Muons

D. Wood\*, Northeastern; K. Heeger, Yale; S. Wolbers, Oregon State

## 7. Documentation:

Is the documentation currently in place adequate to support the project plan, scope, and cost and schedule estimates being presented? If not, where are the deficiencies?

Yes, the fine-grained documentation is particularly good (cost, schedule, BOE). The presentations in the subsystems were well organized and contained the appropriate level of detail for the present review at the pre-CDR level.

Do the NSF CDR and NSF Project Execution Plan fulfill the NSF's expectations for conceptual design?

The PEP contains most of the information required, but it could be better structured to show the matrix between requirements and upgrade elements.

# SC-4 Management, Cost and Schedule

P. Grannis\*, Stony Brook; D. Denisov, FNAL; R. Patterson, Cornell; M. Reichanadter, SLAC

1. Design: Are the project's performance goals well motivated and understood? Is the conceptual design sound and likely to meet the project's performance goals effectively and efficiently? Are the technical approaches adequately justified in the conceptual design, Letter of Intent and related supporting documentation?

The committee believes that the performance goals are well motivated on the basis of extensive collaboration-wide discussions. The translation of these goals to specific deliverables and the technologies chosen are well conceived and form a good basis for successfully achieving the goals.

Finding: Sections 1.1 and 1.2 of the PEP document give the scientific goals for US ATLAS and the flow-down from these goals to the scope and specific deliverables of the project.

Comments: It is important to bear in mind the primary target audience for the PEP and to write to that audience. We suggest that this audience should be the primary decision makers within the NSF who are knowledgeable scientists and administrators, but not specialists in particle physics.

**Recommendation: Rewrite the PEP sections to give enough detail on the P5 science drivers and on the specific examples of the physics considered for scoping, so that a non-expert has a sense of their nature and importance. Explain the main scientific examples so as to provide a non-expert with a general sense of the important issues. Enunciate the accelerator facts and the way that they dictate project scope. For an example, use a relatively high level deliverable (e.g. L1 CALO Trigger) to show how the ATLAS Scope document formulates the nature of the deliverable based on the scientific goals.**

2. R&D: Is there an appropriate R&D plan in place that adequately supports ongoing design development and the down select of alternatives on the currently anticipated time scales?

The international ATLAS and US ATLAS teams have developed an extensive R&D program to demonstrate appropriate solutions to the design and fabrication of deliverables. In many cases this R&D program is already quite mature and its results have been translated into project designs. In other cases, more R&D is needed to reach the technical design report stage.

More specific comments on the R&D program may be found in other subcommittee reports.

3. Scope: Are the project's scope and specifications sufficiently defined to support the cost and schedule estimates? Have the scope and physics performance priorities been clearly identified? Are the scope designations and responsibilities for the NSF and DOE well defined?

The project scope has been established in close cooperation with the International ATLAS management, and forms an adequate basis for making cost and schedule estimates. Setting the scope and responsibilities for the NSF and DOE projects is well advanced, and should continue in the context of the global ATLAS collaboration. In the event that de-scoping is necessary due to budget constraints, there will be a global (within ATLAS) process.

4. Cost and Schedule: Are the cost and schedule estimates credible and realistic for this stage of the project? Has scope contingency been identified and integrated into the project plan? Do the estimates include adequate scope, cost and schedule contingency? Does the cost estimate include realistic assumptions of labor costs, M&S and anticipated support from the core research program?

The reliability of the cost and schedule of the individual subsystems is addressed by other subcommittees. Core costs have been reviewed by the global ATLAS management.

Finding: The committee was shown tables of the fractions of ATLAS core costs that will be undertaken by US ATLAS.

Comment: It will be useful to prepare such tables at a sufficiently low WBS level to indicate which specific subsystems are being undertaken by US ATLAS either in full or in major part. This information will be useful for future reviews.

Finding: The CERN-established Upgrade Cost Group will review the core cost and schedule of each subsystem during development of the TDRs.

Finding: The first line of defense to ensure that the MREFC is within budget is the cost contingency, which is informed by prior ATLAS experience. Should there be a risk of cost overruns beyond contingency, it will be brought to the attention of international ATLAS, which would develop a plan to manage the shortfall. The solution could involve descoping of the upgrade and/or a shift of projects from US to foreign groups. If descoping is required, it will be done to minimize the impact on the physics reach of the upgraded detector.

Comment: US ATLAS presentations should clearly convey the need for interaction with global ATLAS in making descoping decisions.

Comment: The participants' past experience with similar detector projects during initial ATLAS construction and in the Phase I upgrade lend the cost and schedule estimates relatively high credibility compared with many other scientific projects at a similar stage of development. This provides realistic assumptions regarding labor, M&S, and the level of support from the core research program.

Comment: All subdetector schedules show a float between acceptance at CERN and installation of typically 6 months or longer. For some subdetector systems, notably the tracker, this float is small compared with the schedule uncertainties, and funding or technical delays could make the schedule a concern.

5. Risk: Have risks been adequately identified for this stage in the project? Have they been appropriately taken into consideration in the determination of the cost, schedule and scope contingency estimates? Has the risk of possible funding and/or approval delays early in the project life cycle been properly taken into account? Does the R&D plan include mitigation of these risks where possible?

Yes, for this stage in the project. The project has a Risk Management Plan and a Risk Register is in place and is functioning. High level risks are identified and are considered in the assessment of contingency. Risks related to delays, both internal or external to the project, are also included in the Risk Register.

Finding: Many of the mitigations for scope risks indicated in presentations indicated a shift of responsibilities to other collaborating institutes.

In discussion with management, the scope risk mitigation was said to be handled coherently across ATLAS. In most cases the MOU agreements between CERN and collaborating institutions assign responsibility for deliverables and management of any necessary contingency on such institutes. Thus the prospect of shifting scope from non-US to US ATLAS was said to be not likely.

Finding: US ATLAS examines personnel commitments to HL-LHC, Phase I upgrades, R&D and M&O on an annual basis.

Comment: It would be useful to expand the description of scope risk mitigation to fully represent the global ATLAS engagement.

Comment: We commend US ATLAS management for detailed examination of staffing conflicts, particularly during the period of overlap of Phase I upgrades, Run II operations, and Phase 2 R&D and construction. Continuous vigilance will be essential for the success of both projects.

Finding: US ATLAS maintains two complementary risk registers; one for deliverables and one global for reflecting various externally generated risks that affect the whole project.

Comment: The US ATLAS Risk Registry has identified the major risks at the project level, however mitigation actions are not included.

Comment: The committee feels that the telecons preceding the onsite NSF CDR offer an opportunity for the project to define terms, introduce key concepts in the PEP to help clarify the discussions, and avoid misunderstandings.

**Recommendation: Modify the PEP description of the risk management process to make it clear that the full integration team is engaged in concurrent evaluations of both registries.**

**Recommendations: Prior to the CDR Review:**

- 1. Add mitigation actions into the Risk Register for all identified risks.**
- 2. Add description to the PEP (Section 6.3 – Contingency) on how contingency will be tied into risk management.**

**Recommendation: After the CDR Review:**

- 1. Fully develop the risk register with impact assessment. Consider schedule risks as well as cost risks to justify schedule float.**
- 2. Include the possible instances of failures of deliveries by non-US collaborators in the risk register.**

## 6. Management and ES&H:

## Management and ES&H

Is the project being effectively managed at this stage?

\* Yes, the project is effectively managed both at the level of the International and US ATLAS organizations. The management organization is well defined and has adequate level of authority.

Are the roles and responsibilities of the managers at all levels well understood by the principals?

\* Yes, the organization structure of the HL-LHC organization follows closely proposed WBS structure and is developed based on successful experience with original ATLAS construction and Phase I US ATLAS upgrade project.

Do the management structure and processes effectively support the design effort?

\* Yes, there are well organized efforts, including R&D efforts, development of the documentation as well as engineering efforts which are coherently progressing over the entire US ATLAS HL-LHC organization.

Are the criteria, processes, and timeframes for the major decisions concerning down-selects, scope optimization, and assignment of activities well understood?

\*In most cases the selection for the US ATLAS upgrade activities and scope has already been accomplished and supported by CERN initiated review bodies. This was done in close cooperation with international ATLAS collaboration and based on the funding guidelines from US funding agencies. There are well defined scope contingency and scope opportunities which will be finalized by the time of TDRs.

Is the integration with International ATLAS well defined and understood?

\* Yes, the HL-LHC project has been developed in close cooperation with International ATLAS. There is well defined coordination between two projects and US ATLAS members hold important positions in the International ATLAS HL-LHC upgrade organization.

Has the rationale for the NSF and DOE roles been clearly articulated, and are they well motivated and optimized?

\* Yes, there are clearly identified elements of the project which will be supported by NSF or DOE funding. The project optimized the division to minimize inefficiencies and reduce overall project cost. The rationale for the roles is clearly articulated and based on the technical experience of the involved groups.

Are ES&H aspects being properly addressed, and are the plans sufficient given the project's current stage of development?

\* Yes, the project ES&H plan seems sensible but this committee has not had time to evaluate this question in detail..

Finding: The ATLAS TDR schedule is consistent with the US agency review schedules.

7. Documentation: Is the documentation currently in place adequate to support the project plan, scope, and cost and schedule estimates being presented? If not, where are the deficiencies? Do the NSF CDR and NSF Project Execution Plan fulfill the NSF's expectations for conceptual design?

**Finding:** The draft PEP closely follows the guidance provided in the NSF Large Facilities Manual, and provides extensive, useful information on the MREFC plan, cost, schedule and organization.

Finding: The organization charts for US ATLAS showed in some cases “TBD” positions without names.

Comment: To the extent that they are known, it will be useful to identify in the PEP those individuals who have been tasked with technical and integration roles.

Comment: Currently, the Project Manager and Deputy Project Manager are both defined as “Acting”. We expect that people will be identified for these positions after the NSF CDR and DOE CD-0 approval, following global ATLAS and US processes.

Comment: We believe that the description of the system integration (Section 2.5.2 of the PEP) would benefit by being broadened to include the global ATLAS system integration context.

Comment: it would be useful to include discussion in the PEP of how value engineering throughout the design phase would be used to constrain costs.

**Best wishes for a successful CDR!**

# Charge (1)



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Managed by Brookhaven Science Associates  
for the U.S. Department of Energy

## **Associate Laboratory Director's Review of the U.S. ATLAS Phase II Upgrade Project January 20-22, 2016 Charge to the Review Committee**

The European Organization for Nuclear Research (CERN) is planning upgrades to the Large Hadron Collider (LHC) complex for the second phase (Phase II) of high luminosity data collection ( $5\text{-}7.5 \times 10^{34} \text{ cm}^{-2}\text{sec}^{-1}$ ), which is scheduled to begin in 2026. The associated upgrade plans for the ATLAS (A Toroidal LHC ApparatuS) Experiment have been reviewed by the LHC Experiments Committee (LHCC), and the collaboration has been approved to move forward with its Technical Design Reports (TDRs) and to begin formal negotiations of assignments and responsibilities among the funding agencies. Accordingly, the U.S. ATLAS collaboration, in conjunction with the Department of Energy (DOE) and the National Science Foundation (NSF), has formally begun the process of developing the scope and project plan for the U.S. commitment to the ATLAS Phase II upgrade. DOE submission of a Critical Decision 0 (CD-0), and the submission by the U.S. ATLAS collaboration of a Conceptual Design Report (CDR) to the NSF for the consideration of a Major Research Equipment and Facilities Construction (MREFC) award, are both planned for early CY 2016.

The purpose of this review is to assess the maturity and status of the U.S. ATLAS Phase II project plan, with the goal of evaluating its state of readiness for meeting agency expectations for a project in the conceptual stage. Toward that end, the committee is asked to address the following specific items, and to provide recommendations for improvements:

# Charge (2)

1. Design: Are the project's performance goals well motivated and understood? Is the conceptual design sound and likely to meet the project's performance goals effectively and efficiently? Are the technical approaches adequately justified in the conceptual design, Letter of Intent and related supporting documentation?
2. R&D: Is there an appropriate R&D plan in place that adequately supports ongoing design development and the down select of alternatives on the currently anticipated time scales?
3. Scope: Are the project's scope and specifications sufficiently defined to support the cost and schedule estimates? Have the scope and physics performance priorities been clearly identified? Are the scope designations and responsibilities for the NSF and DOE well defined?
4. Cost and Schedule: Are the cost and schedule estimates credible and realistic for this stage of the project? Has scope contingency been identified and integrated into the project plan? Do the estimates include adequate scope, cost and schedule contingency? Does the cost estimate include realistic assumptions of labor costs, M&S and anticipated support from the core research program?
5. Risk: Have risks been adequately identified for this stage in the project? Have they been appropriately taken into consideration in the determination of the cost, schedule and scope contingency estimates? Has the risk of possible funding and/or approval delays early in the project life cycle been properly taken into account? Does the R&D plan include mitigation of these risks where possible?

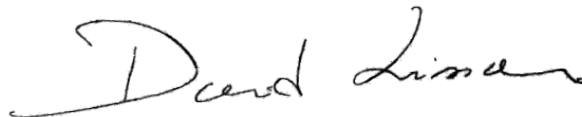
# Charge (3)

6. Management and ES&H: Is the project being effectively managed at this stage? Are the roles and responsibilities of the managers at all levels well understood by the principals? Do the management structure and processes effectively support the design effort? Are the criteria, processes, and timeframes for the major decisions concerning down selects, scope optimization, and assignment of activities well understood? Is the integration with International ATLAS well defined and understood? Has the rationale for the NSF and DOE roles been clearly articulated, and are they well motivated and optimized? Are ES&H aspects being properly addressed, and are the plans sufficient given the project's current stage of development?
7. Documentation: Is the documentation currently in place adequate to support the project plan, scope, and cost and schedule estimates being presented? If not, where are the deficiencies? Do the NSF CDR and NSF Project Execution Plan fulfill the NSF's expectations for conceptual design?

The review will take place on Wednesday-Friday, January 20-22, 2016, at BNL. A closeout will be presented to the Laboratory and the project team on the third day. It is requested that the committee submit its final report to me by Friday, February 5.

I very much appreciate your willingness to lend your time and expertise to this significant step in the U.S. ATLAS review process, and look forward to receiving your assessment.

Sincerely,



David Lissauer  
Deputy Associate Laboratory Director for  
Nuclear and Particle Physics  
Brookhaven National Laboratory

# Agenda (1)

## Wednesday, January 20, 2016 – Brookhaven Center, South Room (Bldg 30)

8:00 am	Executive Session (60').....Lissauer
9:00 am	Welcome (10').....Mueller
9:10 am	Project Overview and Scope (20'+10').....Rajagopalan
9:40 am	NSF CDR Preparations (20'+10').....Tuts
10:10 am	Technical Overview, R&D (20'+5').....Evans
10:35 am	Break
10:50 am	Silicon Pixels (20'+5').....Grenier
11:15 am	Silicon Strips (20'+5').....Haber
11:40 am	Global Mechanics (15'+5').....Anderssen
12:00 pm	Data Handling/DAQ (15'+5').....Zhang
12:20 pm	Trigger (15'+5').....Lipeles
12:40 pm	Lunch
1:40 pm	Muon (15'+5').....Schwarz
2:00 pm	LAr Calorimeter (20'+5').....Parsons
2:25 pm	Tile Calorimeter (15'+5').....Oreglia
2:45 pm	Schedule Contingency (30')
3:15 pm	Break (15')
3:30 pm	Subcommittee Breakout Sessions/Drill Downs (60') <ul style="list-style-type: none"> <li>• Management, Cost and Schedule – Instrumentation Large Conference Room</li> <li>• Silicon (Pixels, Strips and Global Mechanics) – Physics 2-84</li> <li>• Calorimeter (LAr, TileCal) – Physics 2-160</li> <li>• Muon, Trigger, DAQ and Data Handling – Physics 2-219</li> </ul>
4:30 pm	Subcommittee Executive Sessions (30')
5:00 pm	Full Committee Executive Session (90').....Ritz
6:30 pm	Adjourn
7:00 pm	Dinner

# Agenda (2)

## **Thursday, January 21, 2016 – Instrumentation Large Conference Room**

8:00 am	Responses to Questions	
9:00 am	Subcommittee Breakout Sessions/Drill Downs	
12:00 pm	Lunch	
1:00 pm	Subcommittee Breakout Sessions/Drill Downs	
3:00 pm	Subcommittee Executive Sessions	
4:00 pm	Full Committee Executive Session.....	Ritz
6:00 pm	Adjourn	

## **Friday, January 22, 2016 – Brookhaven Center, South Room (Bldg 30)**

8:00 am	Executive Session/Committee Report Writing	
10:00 am	Full Committee Dry Run.....	Ritz
12:00 pm	Working Lunch	
1:00 pm	Closeout Presentation	
2:00 pm	Adjourn	